# FOUNDATION INVESTIGATION
# PROPOSED APARTMENT BUILDING
# MOANALUA, OAHU, HAWAII
# FOR
# VISTA DEL MAR
# (DR. TUNNEL STABILITY)

DAMES & MOORE NO. 3043-001-11

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October 2, 1970

Adrian Wilson & Associates
700 Bishop Street
Honolulu, Hawaii 96813

Attention: Mr. Richard Johnston

Gentlemen:

Submitted herewith are six copies of our report titled "Foundation Investigation, Proposed Apartment Building, Moanalua, Oahu, Hawaii for Vista Del Mar."

The scope of work was described in our proposal dated September 23, 1970. In general, our investigation conformed to the original work scope. However, F.H.A. did not require our interim letter evaluating drainage tunnel stability and preferred that this information be included in this final report.

Preliminary design information was transmitted verbally to your structural engineer to facilitate his design.

Rock core samples will be stored for a six-month period for possible inspection by your contractor or F.H.A. Unless directed otherwise, they will be discarded six months from the date of this report.

It has been a pleasure working on this project with you. Should you have any questions regarding our work, please do not hesitate to contact us.

Yours very truly,

DAMES & MOORE

David C. Liu

DCL HAS jmt

cc: Mr. Benjamin F. Kong
John A. Martin & Associates

FOUNDATION INVESTIGATION

PROPOSED APARTMENT BUILDING

MOANALUA, OAHU, HAWAII

FOR

VISTA DEL MAR

## SUMMARY

The site is considered excellent for the proposed apartment building and related facilities. The structure can be founded at shallow depths in volcanic tuff rock. The proposed development on the lot will not have any significant effect on the tunnel which extends beneath the site. Conversely, the presence of the tunnel will not affect the proposed construction.

## INTRODUCTION

This report contains the results of our foundation investigation for a proposed apartment building in Moanalua, Oahu, Hawaii. The apartment site is located in the Lakeside Development Unit 1, and its general location is shown on the Map of Area, Plate 1. More specifically, the building site is to be situated on the southeast corner of Ala Napunani and Ala Ilima Streets as shown on the Plot Plan, Plate 2.

The scope of our work was to develop subsurface information which would be applicable to project design and construction. Specifically, three borings were to be drilled, and samples of the subsurface materials obtained for evaluation of

their engineering properties. Also, our work was to include an evaluation of the effects of the proposed construction on the drainage tunnel beneath the site.

## PROJECT CONSIDERATIONS

It is our understanding that the proposed apartment building will have a height of seven stories with an open first floor for at-grade parking. The structure will be supported on ten columns, which will impose maximum total loads of 1,000 kips each to the foundations. A one-story recreation building and a swimming pool will be located along the north edge of the site. At-grade parking will be provided around the periphery of the building. A small retaining wall, with a height of about four feet, is to be constructed along the south edge of the property to retain the parking area.

The proposed ground floor elevation at the parking area beneath the structure is 80.4 feet. The proposed pool deck and recreation building will be at elevation 80.9 feet. Minor cutting and filling will be required at the site.

It is our understanding that the apartment building will be constructed with F.H.A. mortgage insurance.

## SITE CONDITIONS

### SURFACE CONDITIONS

Presently, the site is occupied by two construction

shacks. A water line has been installed to service the contractor's office. Several piles of volcanic cobbles and boulders are stacked in a random manner near the south side of the proposed apartment building.

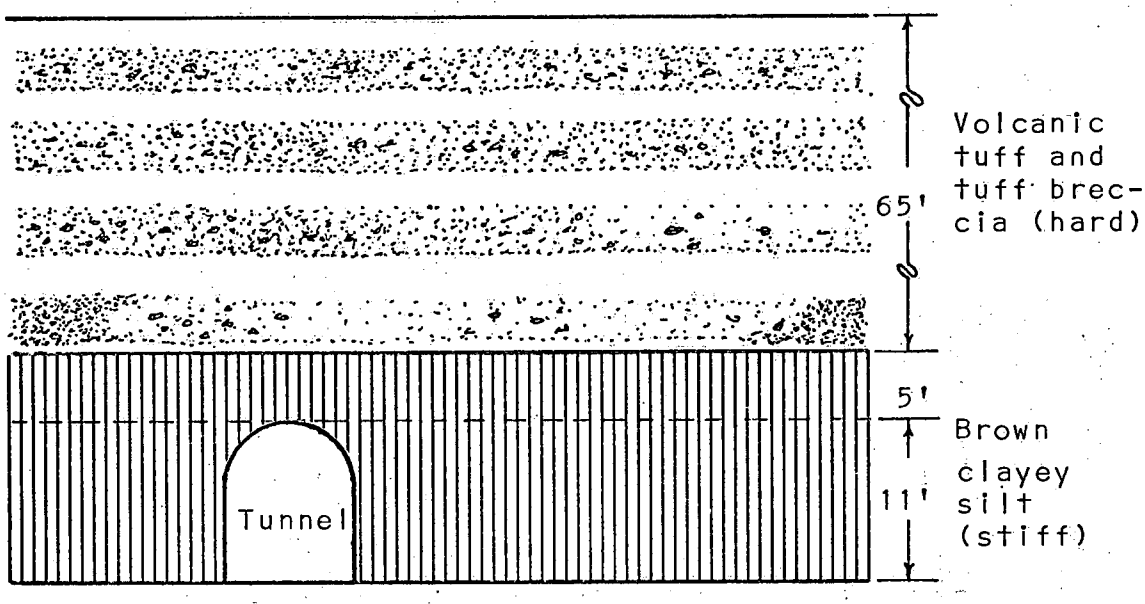
Surface topography varies from about 81 feet along the west property line (Ala Napunani) to 74 feet at the southeast property corner. Generally, the site is relatively flat. Some brush and grass are growing on the ground surface. Also, a small garden has been cultived adjacent to the contractor's shack.

SUBSURFACE AND TUNNEL CONDITIONS

Geologically, the site is situated on the rim of Salt Lake Crater, a secondary eruption in the later volcanic stages of Oahu's development. Volcanic ash and ejecta have been cemented in place to form hard volcanic tuff and tuff breccia rock.

A drainage tunnel was constructed by tunnelling under the site. This tunnel is horse-shoe-shaped and carries drainage from Salt Lake to a storm sewer near Puuloa Road. The tunnel has a width of about 10 feet and height of 11 feet and is lined with reinforced gunite. The tunnel ceiling is about 70 feet below the ground surface. The tunnel is located in an alluvial brown stiff silt with gravel and occasional cobbles. This

material formed the ground surface prior to the eruption of the Salt Lake eruptions. Based on borings made up through the tunnel ceiling at the time of tunnel construction, the silt has thickness of about five feet above the ceiling. The volcanic tuff forms a thick rock cap between ground surface and the silt. A descriptive sketch is shown below.




To explore the subsurface conditions beneath the site, three borings were drilled at the locations shown on the Plot Plan. These borings were drilled by a subcontractor under our constant field inspection. Cores were obtained in the borings to evaluate the competency of the rock underlying the site. A detailed description of the field exploration, including boring logs, is included in the Appendix to this report.

A very thin fill thickness mantles the site. It is

a brown silty sand with volcanic tuff fragments. It was placed during the grading of Unit 1. At Borings 2 and 3, the fill had a thickness of about four inches. It is conceivable that greater fill thicknesses on the order of one foot exist in some areas of the site. The site originally had as much as 12 feet of volcanic tuff rock which was excavated during grading. The fill was placed to level the exposed rock cut surface. The volcanic tuff and tuff breccia beneath the site exist in alternating layers and have generally horizontal bedding. Occasional poorly cemented zones exist; however, it is generally well cemented and hard. Occasionally, steeply dipping fractures were found in isolated sections of the rock cores. The volcanic tuff rock was encountered throughout the lengths of our borings with the exception of the near surface fill.

Ground water was not encountered in any of our borings. The actual ground water surface is near the tunnel floor at about sea level.

## CONCLUSIONS AND RECOMMENDATIONS

### TUNNEL STABILITY

A review of our files was made to gather existing information regarding the drainage tunnel which exists beneath the site. This information was summarized earlier under SITE CONDITIONS, SUBSURFACE AND TUNNEL CONDITIONS. In summary, the

thickness of the horizontally bedded tuff between the proposed construction and the existing tunnel is about 65 feet. We are of the opinion that the proposed structure would have negligible effects on the tunnel; conversely, the presence of the tunnel would have negligible effects on the proposed construction.

FOUNDATIONS

The seven-story structure can be satisfactorily supported on foundations at shallow depths. We recommend a bearing pressure of 8,000 pounds per square foot on intact competent volcanic tuff rock. This bearing pressure has been developed for total loads. The foundations should be founded a minimum of two feet into the volcanic tuff rock. Total settlement should be less than one-quarter inch, and it would occur during building construction from elastic compression in the rock.

The foundations for the one-story recreation building, adjacent to the pool, may be proportioned utilizing 2,000 pounds per square foot. The foundations may be founded either on volcanic tuff rock or in properly compacted granular fill.

All foundation excavations should be inspected by a qualified soils engineer to verify that the volcanic tuff rock is capable of satisfactorily supporting the imposed loads.

SLABS-ON-GRADE

It is our opinion that building slabs and pool decking

can be satisfactorily supported at-grade. A minimum four-inch thick open graded gravel should be used beneath any concrete slabs in habitable areas. Locally available No. 3 fine rock (3/4-inch maximum to No. 4 minimum sieve size) will be adequate as a base course. A vapor barrier or membrane is not envisioned as necessary under the slabs provided that the base course gradation is sufficient to provide a capillary break.

Concrete pool decking can be constructed immediately over on-site materials or compacted granular fill. No base course should be required provided the ground surface is free of clayey or silty materials.

RETAINING WALLS

A low retaining wall will be required along the southeast property line. We recommend that the retaining wall be designed for an equivalent fluid pressure of 40 pounds per cubic foot. Retaining wall foundations should be proportioned utilizing a 4,000-pound per square foot bearing pressure on intact volcanic tuff.

The walls should have weep holes placed on 15-foot centers to prevent the buildup of any hydrostatic pressures. An 18-inch thick gravel filter layer, composed of No. 3 fine rock, would be suitable to route water to the weep holes. Some precautions should be taken to channel any runoff from higher areas

around the ends of the wall.

SITE GRADING

It is our understanding that some cutting and filling will be required at the site. Fills on the order of one foot will be required in the pool and adjacent areas. The thickest fill would be required at the southeast corner of the site. It would be on the order of four feet in height and retained by a small wall.

In general, on-site materials will be suitable for use in compacted fills provided that the material is free of adobe, debris, and rock pieces in excess of six inches in their maximum dimension. The cobble and boulder piles which exist along the southern portions of the site will either have to be crushed for use in fills or wasted. In view of their limited quantity, it is our opinion that it would be more economical to waste these materials. It may be possible to dispose of the larger pieces at the proposed golf course clubhouse site at Lakeside. Provisions for disposal should be arranged with Sunn, Low, Tom & Hara, Inc., the civil engineers in charge of golf course grading.

The site should be stripped prior to any filling to remove all vegetation and scattered debris. Minor fills should be constructed in six-inch maximum lifts and compacted to 90

percent of the maximum modified density as determined in ASTM Test Method 1557D. Fills beneath pavements should be compacted to 95 percent compaction in the upper 12 inches to support traffic loads. Any fills beneath buildings, slabs and pavements should be inspected to ascertain that the materials and compacted densities are satisfactory.

## EXCAVATIONS

Excavations will be required during foundation construction for the multi-story structure including the elevator shaft and for the swimming pool. Based on our prior experience in the Salt Lake volcanic tuff formation, mass excavation can be accomplished by tractor equipment with ripper attachment. Excavation in isolated areas, such as foundations, could best be excavated utilizing conventional trenching equipment. Care must be taken in excavating for foundations so that the exposed materials are not disturbed significantly to alter their supporting characteristics. From past experience, flooding the area with water prior to excavation facilitates rock removal. Blasting is not recommended. Too weak NO BLASTING AT ALL!

## PAVEMENT DESIGN

Very little fill exists at the site. It was not feasible for us to perform laboratory CBR tests for pavement design.

Based on test results on compacted volcanic tuff fill within Salt Lake, the CBR value can be expected to range from 30 to 40 on the samples compacted to 95 percent of the maximum dry density. We believe that the site is suitable for a minimum pavement section composed of either 2 inches of asphaltic concrete over 4 inches of base course of $3\frac{1}{2}$ inches of asphalt directly on properly compacted volcanic tuff fill. The base course should have a minimum CBR rating of 85.

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The following Plates and Appendix are attached and complete this report:

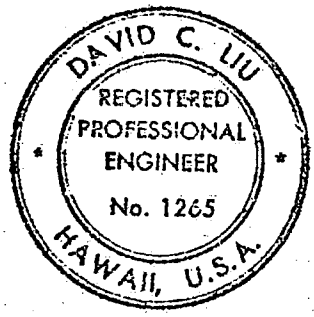
| | | |
|---|---|---|
| Plate 1 | - | Map of Area |
| Plate 2 | - | Plot Plan |
| Appendix | - | Field Exploration |

Respectfully Submitted,

DAMES & MOORE

David C. Liu

DCL HAS jmt




THIS WORK WAS PREPARED BY ME OR UNDER MY SUPERVISION.

REVISIONS BY _____ DATE _____

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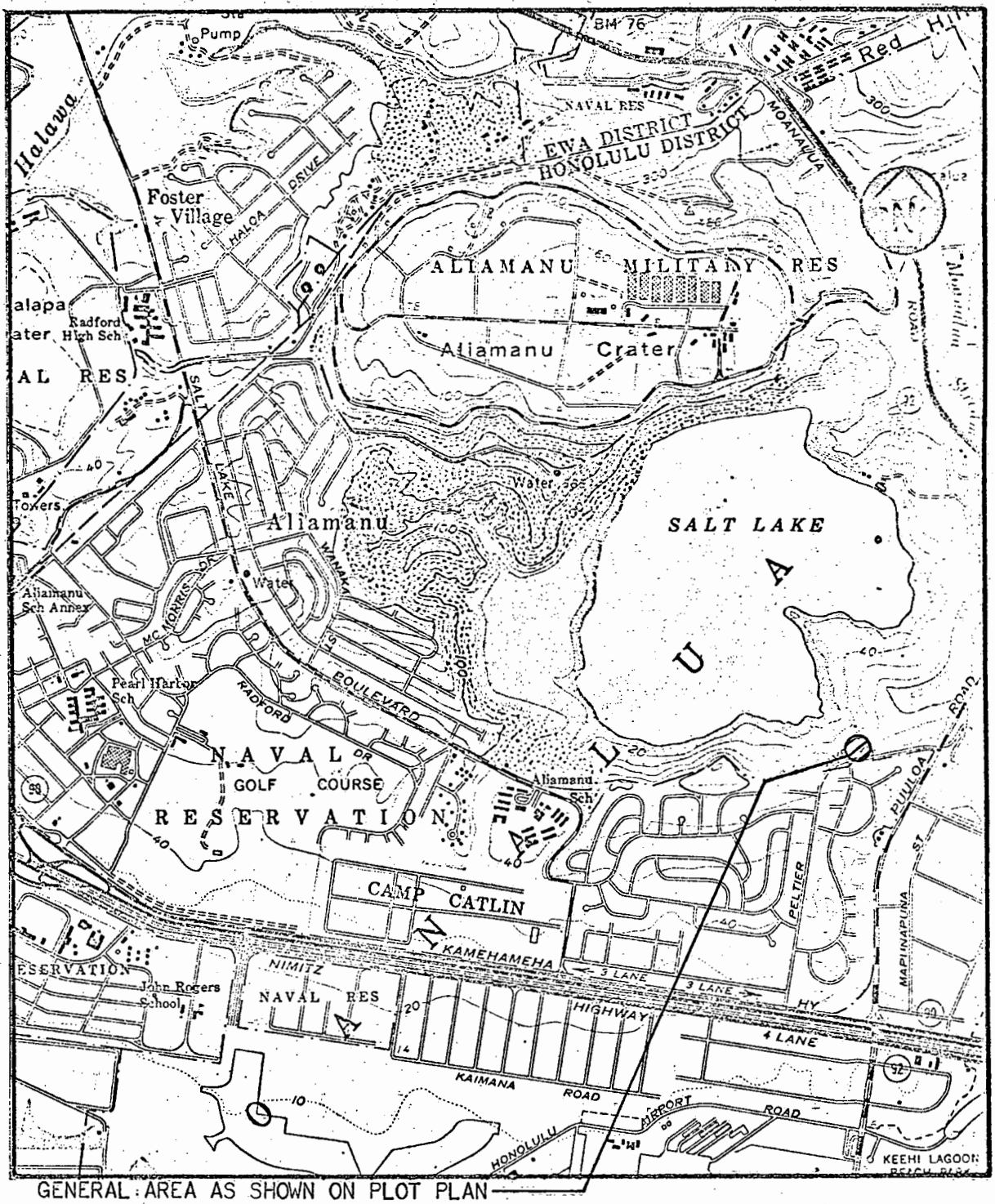
BY Villanueva DATE 4.30.70

CHECKED BY KAS DATE _____

REV. 94




GENERAL AREA AS SHOWN ON PLOT PLAN

# MAP OF AREA

SCALE 1:24000

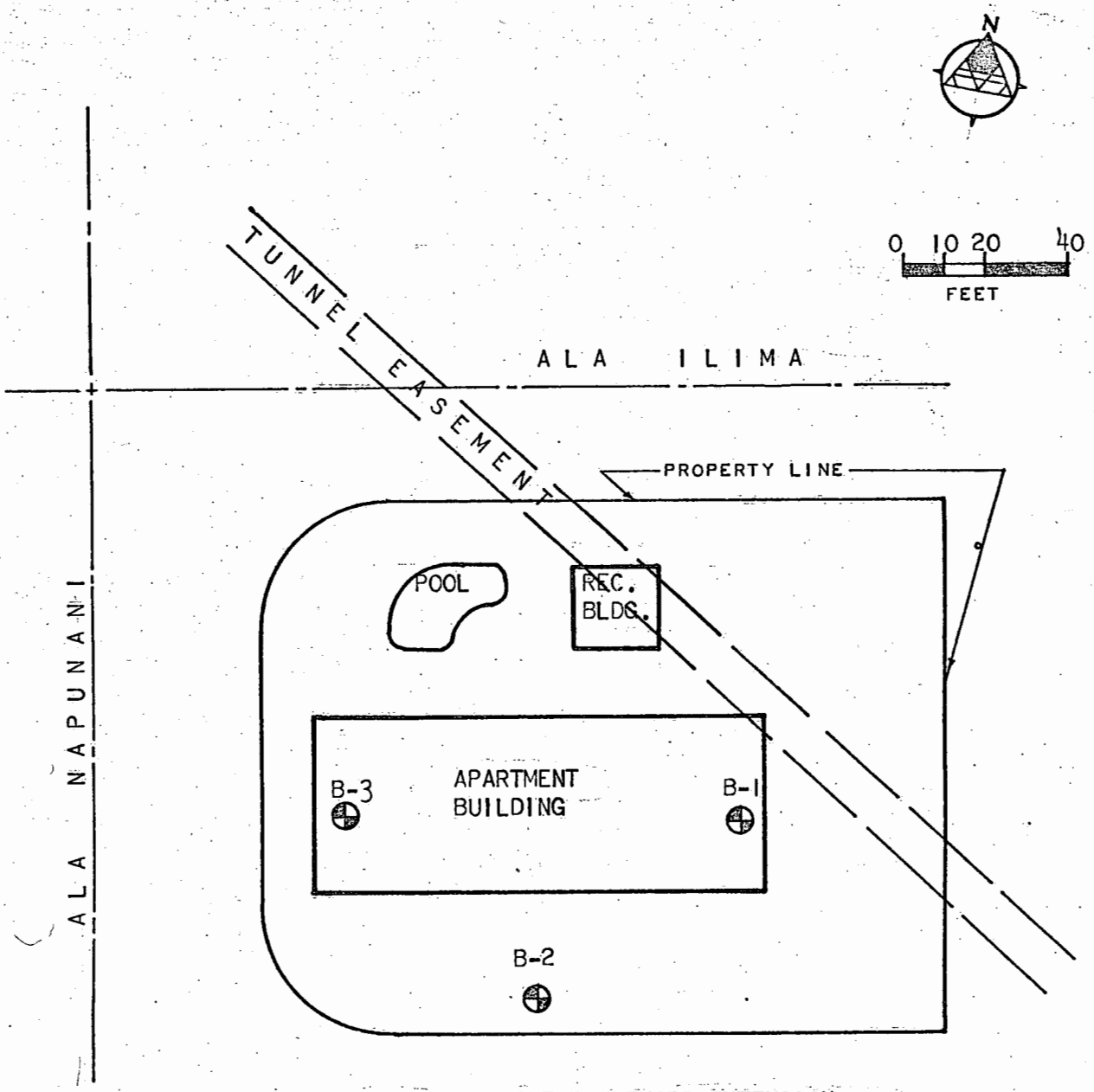
1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 5 0 1 KILOMETER

REFERENCE:
U.S.G.S. QUADRANGLE MAP
HONOLULU, HAWAII
DATED 1959

PLATE 1




PROPOSED SALT LAKE BOULEVARD EXTENSION

REFERENCES:

"LOT GRADING PLAN, LAKESHORE UNIT I
MOANALUA, HONOLULU, OAHU, HAWAII
SHEET 10 OF 11" REVISED 7-14-65
PREPARED BY R.M. TOWILL CORPORATION

PRELIMINARY "PLOT PLAN"
ADRIAN WILSON AND ASSOCIATES
DATED 6-22-70

LEGEND

⊕ BORING DRILLED FOR DAMES AND MOORE

PLOT PLAN

DAMES & MOORE
APPLIED EARTH SCIENCES

PLATE 2

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# APPENDIX

## FIELD EXPLORATION

The subsurface conditions at the site were investigated by drilling three borings at the locations shown on the Plot Plan, Plate 2. One of the borings had to be shifted outside of the building area due to the piles of cobbles and boulders and the construction shack. The results of this boring are believed to be representative of the conditions at the south end of the apartment building. The borings were drilled by the Continental Drilling Company using a rotary drill rig and NX coring equipment. The field exploration was performed under the inspection of our engineer who logged the borings, obtained rock core samples, and made pertinent observations on existing site conditions.

The Logs of Borings are presented on Plates A-1A through A-1C. The materials penetrated have been classified according to the Unified Soil Classification System; a description of this system is included as Plate A-2. Percent recovery for the various coring runs are shown on the Logs of Borings.

- oOo -

The following Plates are attached and complete this Appendix:

| | | |
|---|---|---|
| Plate A-1A | - | Log of Borings, Boring 1 |
| Plate A-1B | - | Log of Borings, Boring 2 |
| Plate A-1C | - | Log of Borings, Boring 3 |
| Plate A-2 | - | Unified Soil Classification System |

466.12 (4-64)

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BY IAValencia DATE 9.30.70
CHECKED BY ✓ DATE 10/2/70

REVISIONS
BY DATE
BY DATE
PLATE OF

## BORING 1

SURFACE ELEVATION 79.3 FEET

| Moisture Content in % | Dry Density in PCF | Blows/Ft. on Sampler | Core and % Recovery | Samples and/or Cores | Depth in Feet | Graph Symbol | Letter Symbol | Description |
|---|---|---|---|---|---|---|---|---|
| | | | NX 100% | | 5 | | | GRAY VOLCANIC TUFF AND TUFF BRECCIA IN ALTERNATING LAYERS; OCCASIONAL FRACTURES; WELL CEMENTED; HORIZONTALLY BEDDED (HARD) |
| | | | NX 50% | | | | | |
| | | | NX 100% | | | | | |
| | | | NX 100% | | | | | |
| | | | NX 100% | | 10 | | | POORLY CEMENTED LAYER BETWEEN 9.5 AND 10.5 FEET |
| | | | NX 100% | | 15 | | | |
| | | | NX 100% | | 20 | | | |
| | | | NX 100% | | 25 | | | POORLY CEMENTED BETWEEN 23.5 AND 24 FEET |
| | | | NX 100% | | 30 | | | POORLY CEMENTED BETWEEN 27 AND 28 FEET |
| | | | NX 100% | | 35 | | | BASALT COBBLE CEMENTED IN VOLCANIC TUFF BED |

BORING COMPLETED AT 39.8 FEET ON 9-24-70
NO WATER ENCOUNTERED

# LOG OF BORINGS

NOTES:

- ▩ -DEPTH AT WHICH UNDISTURBED SAMPLE WAS TAKEN
- ⊠ -DEPTH AT WHICH DISTURBED SAMPLE WAS TAKEN
- ☐ -DEPTH AT WHICH SAMPLE WAS LOST DURING EXTRACTION
- ⊢ -DEPTH AND LENGTH OF CORE RUN

CHARLES O. MOORE

PLATE A-1A

# BORING 2

SURFACE ELEVATION 80.3 FEET

| MOISTURE CONTENT IN % | DRY DENSITY IN PCF | BLOWS/FT. ON SAMPLER | CORE AND % RECOVERY | SAMPLES AND/OR CORES | DEPTH IN FEET | GRAPH SYMBOL | LETTER SYMBOL | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| | | | NX 100% | | 0 | | GM | BROWN SILTY SAND AND VOLCANIC TUFF GRAVEL (MODERATELY DENSE) (FILL) |
| | | | NX 90% | | 5 | | | GRAY VOLCANIC TUFF AND TUFF BRECCIA IN ALTERNATING LAYERS; WELL CEMENTED; HORIZONTALLY BEDDED (HARD) |
| | | | NX 95% | | 10 | | | POORLY CEMENTED BETWEEN 18 AND 19 FEET |
| | | | NX 100% | | 15 | | | |
| | | | | | 20 | | | BORING COMPLETED AT 20.0 FEET ON 9-24-70<br>NO WATER ENCOUNTERED |

REVISIONS BY DATE

FILE 3043.001

CHECKED BY DATE

946.7 (REV. 6-61)

# LOG OF BORINGS

NOTES:

- ▣ -DEPTH AT WHICH UNDISTURBED SAMPLE WAS TAKEN
- ▨ -DEPTH AT WHICH DISTURBED SAMPLE WAS TAKEN
- ▢ -DEPTH AT WHICH SAMPLE WAS LOST DURING EXTRACTION
- H -DEPTH AND LENGTH OF CORE RUN

DAMES & MOORE

PLATE A-1B

# BORING 3

SURFACE ELEVATION 81.3 FEET

| MOISTURE CONTENT IN % | DRY DENSITY IN PCF | BLOWS/FT. ON SAMPLER | CORE AND % RECOVERY | SAMPLES AND/OR CORES | DEPTH IN FEET | GRAPH SYMBOL | LETTER SYMBOL | DESCRIPTION |
|---|---|---|---|---|---|---|---|---|
| | | | NX 90% | | 5 | | GM | BROWN SILTY SAND AND VOLCANIC TUFF GRAVEL (MODERATELY DENSE) (FILL) |
| | | | NX 95% | | 10 | | | GRAY VOLCANIC TUFF AND TUFF BRECCIA IN ALTERNATING LAYERS; WELL CEMENTED; HORIZONTALLY BEDDED (HARD) |
| | | | NX 93% | | 15 | | | |
| | | | NX 100% | | | | | |

BORING COMPLETED AT 19.8 FEET ON 9-25-70
NO WATER ENCOUNTERED

## LOG OF BORINGS

NOTES:

- ▩ -DEPTH AT WHICH UNDISTURBED SAMPLE WAS TAKEN
- ▨ -DEPTH AT WHICH DISTURBED SAMPLE WAS TAKEN
- ☐ -DEPTH AT WHICH SAMPLE WAS LOST DURING EXTRACTION
- H -DEPTH AND LENGTH OF CORE RUN

DAMES & MOORE
PLATE A-1C

REVISIONS BY DATE

FILE 30413.001

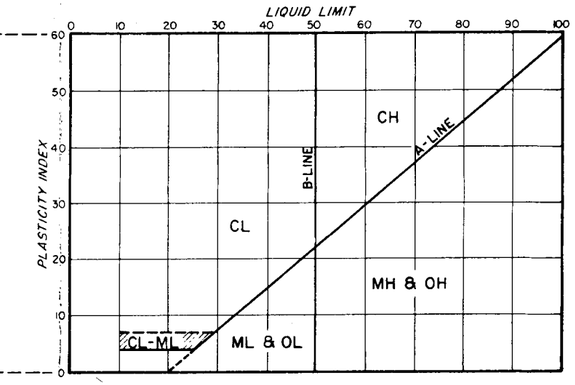
CHECKED BY DATE

946.7 (REV. 6-61)

# SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS | | | GRAPH SYMBOL | LETTER SYMBOL | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS — MORE THAN 50 % OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | GRAVEL AND GRAVELLY SOILS — MORE THAN 50 % OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | CLEAN GRAVELS (LITTLE OR NO FINES) | | GW | WELL-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES |
| | | | | GP | POORLY-GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES |
| | | GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES) | | GM | SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES |
| | | | | GC | CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES |
| | SAND AND SANDY SOILS — MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE | CLEAN SAND (LITTLE OR NO FINES) | | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | | | SP | POORLY-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES) | | SM | SILTY SANDS, SAND-SILT MIXTURES |
| | | | | SC | CLAYEY SANDS, SAND-CLAY MIXTURES |
| FINE GRAINED SOILS — MORE THAN 50 % OF MATERIAL IS SMALLER THAN NO 200 SIEVE SIZE | SILTS AND CLAYS — LIQUID LIMIT LESS THAN 50 | | | ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | | | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | | | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| | SILTS AND CLAYS — LIQUID LIMIT GREATER THAN 50 | | | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS |
| | | | | CH | INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS |
| | | | | OH | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICTY, ORGANIC SILTS |
| HIGHLY ORGANIC SOILS | | | | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

FOR LABORATORY CLASSIFICATION OF FINE-GRAINED SOILS




NOTES:

1. DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE CLASSIFICATIONS.
2. WHEN SHOWN ON THE BORING LOGS, THE FOLLOWING TERMS ARE USED TO DESCRIBE THE CONSISTENCY OF COHESIVE SOILS AND THE RELATIVE COMPACTNESS OF COHESIONLESS SOILS.

| COHESIVE SOILS | (APPROXIMATE SHEARING STRENGTH IN KSF) | COHESIONLESS SOILS | |
|---|---|---|---|
| VERY SOFT | LESS THAN .25 | VERY LOOSE | THESE ARE USUALLY BASED ON AN EXAMINATION OF SOIL SAMPLES, PENETRATION RESISTANCE, AND SOIL DENSITY DATA. |
| SOFT | 0.25 TO 0.5 | LOOSE | |
| MEDIUM STIFF | 0.5 TO 1.0 | MEDIUM DENSE | |
| STIFF | 1.0 TO 2.0 | DENSE | |
| VERY STIFF | 2.0 TO 4.0 | VERY DENSE | |
| HARD | GREATER THAN 4.0 | | |

# GRADATION CHART

| MATERIAL SIZE | PARTICLE SIZE | | | |
|---|---|---|---|---|
| | LOWER LIMIT | | UPPER LIMIT | |
| | MILLIMETERS | SIEVE SIZE* | MILLIMETERS | SIEVE SIZE* |
| SAND | | | | |
| FINE | .074 | #200* | 0.42 | #40* |
| MEDIUM | 0.42 | #40* | 2.00 | #10* |
| COARSE | 2.00 | #10* | 4.76 | #4* |
| GRAVEL | | | | |
| FINE | 4.76 | #4* | 19.1 | 3/4"* |
| COARSE | 19.1 | 3/4"* | 76.2 | 3"* |
| COBBLES | 76.2 | 3"* | 304.8 | 12"* |
| BOULDERS | 304.8 | 12"* | 914.4 | 36" |

*U.S. STANDARD  *CLEAR SQUARE OPENINGS

# PLASTICITY CHART

# SAMPLES

- ■ INDICATES UNDISTURBED SAMPLE
- ⊠ INDICATES DISTURBED SAMPLE
- □ INDICATES SAMPLING ATTEMPT WITH NO RECOVERY
- I INDICATES LENGTH OF CORING RUN

NOTE:
DEFINITIONS OF ANY ADDITIONAL DATA REGARDING SAMPLES ARE ENTERED ON THE FIRST LOG ON WHICH THE DATA APPEAR.

# UNIFIED SOIL CLASSIFICATION SYSTEM

DAMES & MOORE

PLATE A-2

EC 70-925

NOV 5 - 1970

Mr. Benjamin Kong
Suite 435
First Hawaiian Bank Bldg.
Honolulu, Hawaii 96813

Attention: Mr. Jerrold M. Bell

Gentlemen:

Drainage Tunnel Stability
Lakeside Development
Moanalua, Oahu, Hawaii

We have reviewed the foundation investigation report and the engineering calculations evaluating the drainage tunnel stresses due to the construction of the proposed Vista Del Mar Condominium at Lakeside, Moanalua, Oahu, Hawaii. The report and calculations are found to be acceptable.

We have no objections to the construction of the proposed apartment building provided the recommendations of no blasting is adhered to. Blasting will not be permitted.

Very truly yours,

Albert C. Zane

ALBERT C. ZANE
Director and Chief Engineer

HHN:vt

cc: Structural Section
Dames & Moore
Adrian Wilson & Associates